Atomic Data for Modeling X-rays in High-Density Plasmas

Completed Technology Project (2017 - 2019)

Project Introduction

Iron K-shell lines emitted by gas closely orbiting black holes are observed to be grossly broadened and skewed by Doppler effects and gravitational redshift. The accuracy of these spin estimates is called into question because fitting the data requires very high iron abundances, several times the solar value. Meanwhile, no plausible physical explanation has been proffered for why these black hole systems should be so iron rich. The most likely explanation for the super-solar iron abundances is a deficiency in the models, and the leading candidate cause is that current models are inapplicable at densities above 10^18 cm^-3. These models neglect stimulated processes, while simple estimates indicate that the radiation intensities in relativistic line emitting gas are sufficiently high that such processes as stimulated recombination, bound-bound decay, and Compton scattering are likely to be important. Furthermore, at high gas densities rates for atomic processes that allow the survival of iron ions against total ionization are affected by mechanisms related to interactions with nearby ions and electrons. Given iron's relevance as a diagnostic tool in astrophysical plasmas, we will start our development of high-density models by focusing on the Fe K-shell atomic data. The products of this work will be: (i) Rate coefficients for atomic processes affecting iron line formation at a range of densities up to those appropriate for relativistic lines; (ii) ionization balance curves and X-ray emissivities and opacities that are appropriate for high densities and radiation intensities; and (iii) publicly available codes and tables of calculated spectra and emissivities for use in modeling and fitting observed spectra of relativistic iron lines. These new atomic data are required for the detailed modeling of spectra with ~5 eV resolution that will soon be provided by the calorimeter spectrometer aboard the recently launched X-ray mission Hitomi (Astro-H).

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics Research and Analysis

Project Management

Program Director:

Michael A Garcia

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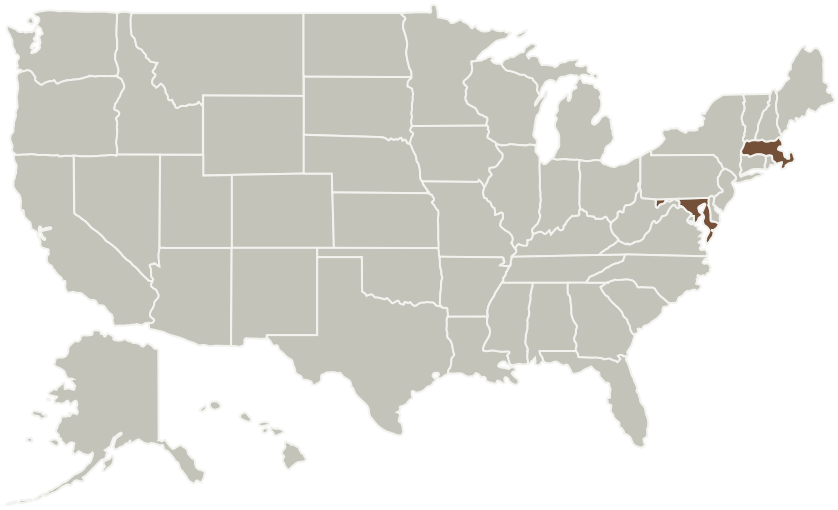
Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations	
Maryland	Massachusetts

Project Management *(cont.)*

Program Manager:

Dominic J Benford

Principal Investigator:

Javier A Garcia

Co-Investigators:

Christine Mcneil
Pascal Quinet
James F Steiner
Patrick Palmeri
Jeffrey Mcclintock
Timothy Kallman

Technology Areas

Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - TX11.2 Modeling
    - TX11.2.4 Science Modeling

Target Destination

Outside the Solar System